

SUBTIDAL ALGAL COMMUNITIES ON THE SOUTH COAST OF IRELAND

John P. CULLINANE* and Padraig M. WHELAN*

ABSTRACT. — The subtidal algal vegetation of the coast of Ireland is poorly known. The distribution of macroalgae at Beenatobeenig Rock, near Smerwick harbour, on the Dingle Peninsula and Cape Clear Island, off the south coast, is described and the depth distribution of many species is compared with recent subtidal reports on algae from the Scilly Isles, Oban, Donegal, Roaringwater Bay and Carrigathorna near Lough Ine. The lowermost limits of algal vegetation was similar at Roaringwater Bay (22 m), Carrigathorna (21-23 m) and Beenatobeenig Rock (22-27 m). Densities of *Laminaria* are compared between Beenatobeenig Rock at 86/m² (max) and Carrigathorna at 222/m². The deepest algal community occurring at Beenatobeenig Rock included *Dictyota dichotoma* and *Rhodymenia* sp., which were the only species found at the deepest stations in the Scilly Isles, Oban and Donegal. In spite of these generalizations there appears to be considerable variation between different sites as to what constitutes the deepest growing algae and also a variation in the depth range of many species in the subtidal.

RÉSUMÉ. — La distribution des macroalgues de la côte sud-ouest de l'Irlande est décrite et l'étagement de nombreuses espèces est comparée avec les récentes observations réalisées sur les algues des îles Scilly. Les limites inférieures de la végétation algale étaient semblables à Roaringwater Bay (22 m), à Carrigathorna (21-23 m) et à Beenatobeenig Rock (22-27 m). Les densités de *Laminaria* ont été comparées et varient de 86/m² (max.) à Beenatobeenig Rock à 222/m² à Carrigathorna. Les communautés les plus profondes sont à Beenatobeenig Rock avec *Dictyota dichotoma* et *Rhodymenia* sp., les seules espèces observées aux plus profondes stations des Scilly, Oban et Donegal. Il existe de larges variations dans la composition des communautés les plus profondes et également des variations dans l'étagement de nombreuses espèces subtidales.

INTRODUCTION

MAGGS & GUIRY (1982) noted that very few subtidal algal communities have been studied in Ireland, and that our first hand knowledge of deep water seaweeds is almost non-existent. On the south coast of Ireland subtidal algal communities have been reported from : Lough Ine (NORTON et al., 1977,

* Botany Department, University College, Cork, Ireland.

reported on fifty seven species down to 23 m), Roaringwater Bay (HISCOCK & HISCOCK, 1980, reported on one hundred and forty-two species down to 23 m), Cork Harbour and Kinsale (CULLINANE & WHELAN, 1981, and WHELAN & CULLINANE, 1981, have reported on *Cryptonemia hibernica* communities down to 11 m), Horseshoe Harbour (CULLINANE & WHELAN, 1982, reported on fifty-eight species down to 6.5 m).

DESCRIPTION AND METHODOLOGY

In June 1981, a survey was carried out near Beenatobeenig Rock (grid ref. Q 403 120) between Smerwick Harbour and Brandon Creek (Cuas) on the Dingle peninsula, Co. Kerry. A similar survey was carried out in June 1982 on the northern shores of Cape Clear Island (grid ref. V 945 210) in Roaringwater Bay, Co. Cork (fig. 1).



Fig. 1. — Map of Ireland showing location of Beenatobeenig Rock and Cape Clear Island.

Near Beenatobeenig Rock the area consists of vertical rockface which rises to 200 m above sea level. In the subtidal the rockface drops steeply to a depth of approximately 20 m (at a distance of 30 m from the cliff face). From 20 m down to 32 m the slope is less steep. The intertidal consists of an almost vertical rock which faces north to the open Atlantic ocean and at the time of the survey there was a swell of some 3 m. This surface turbulence was a major controlling

factor in the infralittoral fringe. Its effect in the subtidal decreased with depth and was not felt below 12 m. The subtidal substrate down to some 22 m consisted of steeply sloping bedrock with deep gullies. At greater depths boulders of about 2 m diameter occurred in sand along with some small protrusions of bedrock and both boulders and bedrock were covered with silt. At 32 m flat rocks covered in silt lay buried in coarse sand. At depths of 22 m to 32 m decreased illumination and increased silting were obviously controlling factors.

The area surveyed on Cape Clear was on the protected side of the island. However, at the time of the survey there was a surface swell, the effects of which were felt by the divers down to 18 m. The shore was far less steeply inclined than at Beenatobeenig Rock. The substrate consisted of bedrock down to 13 m and very large smooth flat boulders from 13 to 18 m. The bedrock was much more furrowed than at Beenatobeenig Rock and presented a variety of steep ridges and gullies with overhangs. The nature of the bedrock made it difficult to find flat surfaces suitable for sampling, except at 2 to 5 m depth where the bedrock formed a smooth gently inclined slope. Sand and silt were not present down to 18 m.

The subtidal was sampled using a 50 x 50 cm frame. At Beenatobeenig Rock sampling was at regular 5 m intervals to a depth of 32 m, but at Cape Clear the irregular nature of the substrate resulted in sampling at less regular intervals (2, 5, 10, 13 and 16 m). At Cape Clear 16 m was the greatest depth at which sampling was carried out, the vegetation, however, was observed at greater depths. All the vegetation within the frame was collected and sorted and identified later. In addition notes were made of the adjacent vegetation which was typical of the depth. The frame was used because of non-biologist SCUBA divers assisting with the survey. It has been the experience of the authors that when using such assistants that best results are obtained by complete clearance of the frame since this resulted in collection of smaller species as might otherwise be overlooked by the non-biologists. A five point broad-based scale of abundance was used to describe the algal cover (see Table 1, Beenatobeenig Rock; Table 2, Cape Clear Island). All depths are quoted relevant to Chart Datum (C.D.). The algal nomenclature used is according to PARKE & DIXON (1976).

OBSERVATIONS

The following observations were made at Beenatobeenig Rock and are summarised in Table 1. Observations made at Cape Clear are summarised in Table 2. Both sets of observations are compared in the discussion section.

Faunal species only, were recorded at 32 m and 27 m with the exception of a single small specimen of *Delesseria sanguinea* at 27 m. The fauna recorded at these depths included the following four species:

Caryophyllia smithi (approx. 100 per m⁻² at 32 m and 27 m and only 9 per m⁻² at 22 m and 3 per m⁻² at 17 m). The species was not observed at depths

TABLE 1

List of the algae recorded from the different depths (in meters below — Chart Datum) at Beenatobeenig Rock. A five point broad-based scale of abundance was used to describe the algal cover

	2 m	7 m	12 m	17 m	22 m	27 m
<i>Aglaozonia</i> (<i>Cutleria multifida</i>)				000		
<i>Audouinella</i> sp. (in <i>Sertularia</i>)		+				
<i>Antithamnion plumula</i>			0			
<i>Bonnemaisonia asparagoides</i>			0			
<i>Brongniatella byssoides</i>		0	0			
<i>Callophyllis laciniata</i>		00	+			
<i>Cryptopleura ramosa</i>	0	00	00	00		
<i>Dictyopteris membranacea</i>		+	+	00		
<i>Dictyota dichotoma</i>	+	00	00	0	+	
<i>Delesseria sanguinea</i>	0000	0000	0000	000	000	0
<i>Desmarestia ligulata</i>		+				
<i>Hypoglossum woodwardii</i>	0	0	0	0		
<i>Kallymenia reniformis</i>	0	00	+			
<i>Lomentaria orcadensis</i>		+	0	+		
<i>Laminaria hyperborea</i>	00	0000	0000	000		
<i>Membranoptera alata</i>	0					
<i>Pterosiphonia parasitica</i>		0	0	0		
<i>Plocanium cartilagineum</i>				+		
<i>Phycodrys rubens</i>	+	+				
<i>Polyneura hilliae</i>	000					
<i>Rhodymenia pseudopalmata</i>			0000	0000	0	
<i>Schottera nicaensis</i>			0000	000		
<i>Zanardinia prototypus</i>				+		

0000 : abundant. Almost total cover of suitable rock.

000 : common. Thin cover.

00 : occasional. Scattered plants.

0 : rare. A few plants seen at that depth.

+: very rare. One or two plants only, seen or collected at that depth.

less than 17 m at this site. NORTON et al. reported it from 6 m downwards.

Echinus esculentus (approx. 1.3 per m⁻² at 32 m and 27 m, 6 per m⁻² at 22 m and 1.2 per m⁻² at 17 m and 12 m).

Asterias rubens (2 per m⁻² at 32 m).

Holothuria forskali (only four specimens were observed over the entire area at both 27 m and 22 m but at 17 m there was approx. 1 per m⁻²).

22 m was the greatest depth at which any appreciable vegetation was observed. At this depth some very small *Laminaria* plants were present. Four plants of *Delesseria sanguinea*, three of *Rhodymenia pseudopalmata*, and one of *Dictyota dichotoma* were recorded from within the frame.

At 17 m *Laminaria hyperborea* was present along with many dead holdfasts. There was a good cover of small sized algae (see Table 1). Thirteen species were

recorded from within the frame and of these, *Cutleria multifida* (*Aglaozonia* phase), *Delesseria sanguinea*, *Schottera nicaeensis* (seventeen plants in the frame) and *Cryptopleura ramosa* were the most abundant, along with *Rhodymenia pseudopalmata* which grew abundantly (twenty seven plants in the frame) on rock. A single specimen of *Zanardinia prototypus* was recorded at this depth (CULLINANE & WHEELAN in press).

At 12 m fifteen species were recorded using the frame (see Table 1). The most abundant species appeared to be the same as at 17 m with twenty four plants of *Rhodymenia pseudopalmata* in the frame and forty-five plants of *Schottera nicaeensis* in the frame. A single small sized specimen of *Kallymenia reniformis* was recorded from the frame and this was the greatest depth at which it was found.

At 7 m fourteen species were recorded from within the frame (see Table 1) including 7 specimens of *Kallymenia reniformis* (found also in a cave mouth at 2 m), *Phycodryis rubens* growing on rock and *Audouinella* sp. in *Sertularia*. *Delesseria sanguinea* was by far the most abundant species.

At depths of approximately 2 m the surface swell made the use of the frame difficult and the data is almost certainly incomplete. However, nine species were observed (see Table 1) growing on rock including *Polyneura hilliae* and *Membranoptera alata*. Near the infralittoral fringe a 2.5 m wide zone of *Alaria esculenta* occurred.

Quantitative estimates of epiphytes were not carried out at Beenatobenig but subjective observations indicated that the epiphytes of *Laminaria hyperborea* were most abundant at the 2 m, 7 m and 12 m depths, at 17 m very few *Laminaria* epiphytes were present and none were recorded deeper than 17 m. The following species were the most abundant *Laminaria* epiphytes along with the depths at which they occurred :

<i>Apoglossum ruscifolium</i> 2 m, 7 m, 12 m	<i>Lomentaria clavellosa</i> 2 m
<i>Antithamnion plumula</i> 7 m, 12 m	<i>Membranoptera alata</i> 2 m, 7 m, 12 m
<i>Antithamnion spirographidis</i> 7 m, 12 m, 17 m	<i>Nitophyllum punctatum</i> 2 m
<i>Bonnemaisonia asparagoides</i> 2 m	<i>Polyneura hilliae</i> 2 m
<i>Callophyllis laciniata</i> 2 m, 7 m	<i>Palmaria palmata</i> 2 m, 7 m, 12 m
<i>Callithamnion</i> sp. 2 m	<i>Polysiphonia urceolata</i> 7 m, 12 m, 17 m
<i>Chaetomorpha melagontum</i> 12 m	<i>Porphyra</i> sp. 7 m
<i>Cryptopleura ramosa</i> 2 m, 7 m, 12 m	<i>Phycodryis rubens</i> 2 m, 7 m, 12 m, 17 m
<i>Delesseria sanguinea</i> 2 m, 7 m, 12 m	<i>Pterosiphonia parasitica</i> 2 m
<i>Hypoglossum woodwardii</i> 2 m	<i>Ptilota plumosa</i> 2 m
<i>Lomentaria orcadensis</i> 2 m, 7 m, 12 m	<i>Rhodymenia pseudopalmata</i> 2 m, 7 m, 12 m
<i>Lomentaria articulata</i> 2 m	

In the immediate subtidal the *Alaria esculenta* gave way to *Laminaria hyperborea* at about 2 m depth. Only a small number of *Laminaria digitata* occurred in the *Alaria hyperborea* fringe and *Saccorhiza polyschides* was almost completely absent. *Laminaria hyperborea* extended down to 22 m where it was present in the form of very small plants approximately 3 per m². At this level, the shading effect of these plants on the other algal species was of little or no

TABLE 2

List of the algae recorded from the different depths off the northwestern coast of Cape Clear Island using the same scale of abundance as in Table 1. 16 m represents the lowest depth reached during the dive but the vegetation extended further than that depth.

	2 m	5 m	10 m	13 m	16 m
<i>Aglaozonia (Cutleria multispida)</i>		000	000	000	00
<i>Apoglossum ruscifolium</i>	+				
<i>Brongniartella byssoides</i>		+	+	0	0
<i>Bonnemaisonia asparagoides</i>				0	
<i>Callophyllis laciniata</i>	00	00			
<i>Cryptopleura ramosa</i>	0	0	0	00	0000
<i>Desmarestia aculeata</i>		+		0	+
<i>Delesseria sanguinea</i>		00	00	00	000
<i>Dictyota dichotoma</i>		0	0	00	00
<i>Dictyopteris membranacea</i>			+	0	00
<i>Desmarestia ligulata</i>		+			
<i>Desmarestia aculeata</i>		0			
<i>Desmarestia viridis</i>		0			
<i>Gymnogongrus crenulatus</i>		+			
<i>Halarachnion ligulatum</i>		+	+	+	
<i>Hypoglossum woodwardii</i>		0	00	0	
<i>Kallymenia reniformis</i>		+	0	+	+
<i>Laminaria hyperborea</i>		0000	000	000	00
<i>Laminaria saccharina</i>				00	
<i>Lomentaria clavellosa</i>		+	+	+	+
<i>Lomentaria orcadensis</i>		+	+	0	0
<i>Membranoptera alata</i>			+		
<i>Nitophyllum punctatum</i>		+	+	0	0
<i>Pterosiphonia parasitica</i>		00	0	0	
<i>Plocamium cartilagineum</i>		+	+	0	
<i>Polyneura hilliae</i>	000	0	+	+	
<i>Phycodrys rubens</i>		+	+		
<i>Phymaria elegans</i>	0				
<i>Phyllophora pseudoceranoides</i>	00	0			
<i>Phyllophora crispa</i>		+			
<i>Ptilota phymosa</i>		+			
<i>Rhodomela confervoides</i>		+	0	00	
<i>Rhodymenia pseudopalmitata</i>	+			00	000
<i>Schottera nicaeensis</i>	+				

significance. The density of the *Laminaria* varied as follows: 6 plants per m^{-2} at 17 m, 15 plants per m^{-2} at 12 m, 18 plants per m^{-2} at 7 m, and 30, 84 and 86 plants per m^{-2} at depths of 5 m, 4 m, and 3 m respectively. The *Laminaria* at 7 to 17 m was almost exclusively old plants in the 3 to 7 year old age group and none were found to be less than 3 years old. Old dead basal parts were abundant at 17 m. At 3 to 5 m the *Laminaria* was never more than three years old. Plants more than 7 years old were not recorded at any depth.

DISCUSSION

Some comparisons can be made with the very thoroughly studied headland at Carrigathorna near lough Ine reported by NORTON et al. (1977), and also with the findings of HISCOCK and HISCOCK (1980) in Roaringwater Bay, MAGGS & GUIRY (1982), off Donegal, and NORTON (1968) in the Scilly Isles.

The lowermost limits of the algal vegetation was similar at Beenatobeenig (22-27 m) to Carrigathorna (21-23 m) and Roaringwater Bay (22 m). The occurrence of *Delesseria sanguinea* at 27 m at Beenatobeenig appears to be the second deepest algal record in Ireland to that of MAGGS & GUIRY, who reported macrovegetation down to 32 m off Donegal.

Although the macrovegetation extended deeper off Donegal the lowermost limits of the *Laminaria* was similar namely about 20 m off Donegal and 22 m at Beenatobeenig. At Cape Clear, however, *Laminaria* observed showed no indication of decreasing in size or numbers down to 17 m whereas at Carrigathorna the lowermost limit of *Laminaria* was 17.5 m.

Off Donegal the vegetation extended some 12 m below the limit of the *Laminaria*. At Carrigathorna the vegetation extended 3.5 to 5.5 m below the *Laminaria* and some 5 m below *Laminaria* at Beenatobeenig. There is perhaps a need to define more accurately what is meant by the limit of the *Laminaria* and especially the limit of the *Laminaria* forest (canopy or zone). As stated earlier *Laminaria* extended down to 22 m at Beenatobeenig but the shading effect of the *Laminaria* canopy forest ceased at about 17 m.

NORTON et al. (1977) made a very detailed study of the numbers, weights, sizes and ages of the *Laminarias* down to 17.5 m. They noted that juvenile plants 0-1 year age group were much more numerous in shallow water and reported by far the greatest number of plants at the 3 m depth, all of which were four years old or younger with approximately 60% in the 0-1 year age group. Likewise the largest numbers of *Laminaria* and the youngest plants were found between 3 and 5 m at Beenatobeenig. The *Laminaria* apparently occurred in much greater numbers at Carrigathorna than at Beenatobeenig. 86 plants per m² was the maximum at the latter site whereas as many as 222 per m² were recorded at Carrigathorna.

NORTON et al. found that the undergrowth algae were most abundant in shallow water and again immediately below the *Laminaria* forest (i. e. 17.5 m) but became very sparse by 21 m. At Beenatobeenig the only algae occurring deeper than the *Laminaria* (as distinct from the *Laminaria* forest) were two specimens of *Delesseria sanguinea* and the undergrowth algae were most abundant down to 17 m i. e. more or less the limits of the *Laminaria* «forest». The difference may be explained by the apparent much denser canopy of *Laminaria* at Carrigathorna and the somewhat shallower lower limit of the *Laminaria* at that site.

MAGGS & GUIRY, found that *Rhodophyllis* sp. was the only species at the lower limit of algae. NORTON et al. found *Rhodophyllis divaricata* at 10-21 m

but not at 23 m. This species was not found at either Beenatobeenig or Cape Clear. *Delesseria sanguinea* was not only the deepest growing macroalga at Beenatobeenig but was also without doubt the most abundant and widespread underflora species. NORTON et al. also reported *Delesseria* from all depths 2-23 m, it being most abundant between 15 and 23 m. The deepest algal community at Beenatobeenig included *Dictyota dichotoma* and *Rhodymenia* sp. which were the only species found at the deepest stations in the Scilly Isles, Oban and Donegal. NORTON et al. reported these two species down to 21 m. At both Beenatobeenig and Cape Clear *Rhodymenia pseudopalmata* was present on rock only below 12 m. At Lough Ine, Co. Cork, however, *Rhodymenia pseudopalmata* and *R. pseudopalmata* var. *ellisiae* were seen by the authors to be abundant on rock at depths far less than 12 m. At Beenatobeenig and Cape Clear *Dictyota dichotoma* and to a lesser extent *Rhodymenia* sp. took on a more prostrate creeping form near their lowermost limits.

The findings at Beenatobeenig agree with those of MAGGS and GUIRY in Donegal and NORTON et al. at Carrigathorna in that two of NORTON's deep water species from the Scilly Isles, namely, *Cryptopleura ramosa* and *Kallymenia reniformis* were recorded only from well above the lower limit of algae. *Kallymenia* was recorded at 2 to 12 m at Beenatobeenig, 5 to 16 m at Cape Clear, 6 to 16 m at Carrigathorna. MAGGS and GUIRY collected *Kallymenia* «below 15 m» but do not quote its lower limit. At Beenatobeenig *Cryptopleura* did not grow below 17 m. At Cape Clear, however, it was found in abundance at 16 m and may well have grown at much greater depths at this site.

Dictyopteris membranacea has been reported from the intertidal (JOHNSON 1982; DE VALERA & PARKES, 1957; BURROWS & DIXON, 1959). The species is found in the subtidal down to great depths namely 16 m at Cape Clear, 17 m at Beenatobeenig, 23 m at Carrigathorna and even as deep as 30 m at the Scilly Isles and below 30 m in l'Archipel de Glénan (L'HARDY-HALOS et al., 1974).

NORTON et al. recorded *Polyneura hilliae* at 6-23 m with its maximum standing crop at 21 m and NORTON recorded this species from 0 to 21 m in the Scilly Isles. At Beenatobeenig this species was found only at 2 m at Cape Clear where the species was much more plentiful it was found at depths of 2 to 13 m. At Cape Clear, however, the plants were most numerous and were extremely large at 2 m, those at 10 and 13 m being much smaller in size and fewer in number.

Lomentaria orcadensis is a species which occurs in both the intertidal and subtidal. It was found as deep as 16 m and 17 m at Cape Clear and Beenatobeenig respectively and below 25 m off Donegal whereas, at Carrigathorna it was not recorded below 6 m.

Pulmaria palmata was not recorded below 5 m at Cape Clear, 6 m at Carrigathorna, 9 m in the Scilly Isles but occurred as an epiphyte at 12 m at Beenatobeenig.

Polysiphonia urceolata was not present on rock at either Cape Clear or Beenatobeenig. At the latter location and at Carrigathorna it occurred as an

epiphyte down to 17 m. However, at Carrigathorna, it grew on rock at 19 to 21 m and in the Scilly Isles it grew on rock at 30 to 33 m. Its absence from rock at Cape Clear and Beenatobeenig excluded it from being amongst the deepest growing algae at those sites.

ACKNOWLEDGEMENTS

We are grateful to the members of the Daunt Diving Club, Cork, for their assistance with the Beenatobeenig study and to Fionnuala Walsh for assistance with the Cape Clear study.

BIBLIOGRAPHY

- BURROWS, E.M. and DIXON, P.S., 1959 — List of marine algae from the west coast of Ireland collected by members of the Third International Seaweed Symposium. *Br. Phycol. Bull.* 1 : 47-60.
- CULLINANE, J.P. and WHELAN, P.M., 1981 — Ecology, distribution and seasonality of *Cryptonemia hibernica*, Guiry et Irvine on the south coast of Ireland. *Proc. Xth Int. Seaweed Symposium* Gotenborg, Sweden : 259-264.
- CULLINANE, J.P. and WHELAN, P.M., 1982 — Subtidal algae of Horseshoe Harbour (Sherkin Island). *Ir. J. of Env. Sc.* 2 : 61-65.
- CULLINANE, J.P. and WHELAN, P.M., (in press) — Seaweed records from the south coast of Ireland. 1. *Ir. Nat. J.*
- HISCOCK, K. and HISCOCK, S., 1980 — Sublittoral plant and animal communities in the area of Roaringwater Bay. *J. of Sherkin Island I* : 7-47, south west Ireland.
- JOHNSON, T., 1892 — Seaweeds from the west coast of Ireland. *Ir. Nat.* 1 : 4-6.
- L'HARDY-HALOS, M.Th., CASTRIC-FEY, A., GIRARD-DESCATOFRE, A. and LA FARGUE, F., 1974 — Recherches en scaphandre autonome sur le peuplement végétal du substrat rocheux : l'Archipel de Glénan. *Bull. Soc. Scient. Bretagne* 48 : 103-128.
- MAGGS, C.A. and GUIRY, M.D., 1982 — Notes on Irish marine algae - 5. Preliminary observations of deep water vegetation off west Donegal. *Ir. Nat. J.* 20, 9 : 357-361.
- NORTON, T.A., 1968 — Underwater observations on the vertical distribution of algae at St Mary's, Isles of Scilly. *Br. Phycol. Bull.* 3 (3) : 585-588.
- NORTON, T.A., HISCOCK, K. and KITCHING, J.A., 1977 — The ecology of Lough Ine XX. The *Laminaria* forest at Carrigathorna. *J. Ecol.* 65 : 919-941.
- PARKE, M. and DIXON, P.S., 1976 — Check-list of British marine algae-third revision. *J. mar. biol. Ass. U.K.* 56 : 527-594.
- VALERA (de), M. and PARKES, H.M., 1957 — Algae of the east and west coasts, pp. 58-61. In MEENAN, J. and WEBB, D.A. (Eds.) : A view of Ireland. Dublin. British Association for the Advancement of Science.
- WHELAN, P.M. and CULLINANE, J.P., 1981 — The occurrence of *Cryptonemia hibernica* Guiry et Irvine on the south coast of Ireland. *Cryptogamie, Algologie* 2 (3) : 179-184.